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DECLARATION

I, Christoph Brogle, residing at Scheuchzerstrasse 132, 8006 Zürich, Switzerland, do hereby declare that I am conversant with the English and German languages and am a competent translator thereof. I declare further that the following is a true and correct translation made by me into English of the German text of Swiss Patent Application No. 02 476/00.

Signed this 2 May 2003

Ch. Brogle

Christoph Brogle

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ECCENTRICALLY SPOKED BICYCLE WHEEL

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STATE OF PRIOR ART

The invention concerns an eccentrically spoked bicycle wheel, the spoke system of which in the axial section of the wheel has an amount of dish, so that the spoke tensions are different on both sides of the wheel. (The inventor has previously already dealt with a similar subject in his patents „Rim for a spoked bicycle rear wheel„.). This wheel can be utilized in a bicycle as front wheel or as rear wheel.

A conventional bicycle front wheel of this kind has a front wheel hub, which is fixed in the fork of the bicycle frame and on one side of which, e.g., a brake disc is affixed as a component part of a disc brake. A conventional bicycle rear wheel of this kind has a rear wheel hub, which is fixed in the bicycle frame and on one side of which a sprocket set set for the drive chain is affixed. The hub flanges on the sides of the front - and rear wheel hub are connected by means of spokes under tension with a conventional wheel rim, which carries a tyre.

In a rear wheel the set of sprocket sets causes an undesirable lateral displacement of the centre plane of the hub flanges from the centre plane of the rim in the direction towards the opposite side of the sprocket set. As a result of this displacement amounting to several millimetres, which is known as an amount of dish, the tension of the spokes on the side of the sprocket set is greater than the tension of the spokes on the opposite side of the sprocket set to such a degree, that the stability (under load) of the rear wheel is strongly diminished. For this reason it is desirable, that the spoke tensions of the rear wheel are equalized to as great an extent as possible.

In the case of a front wheel, the lateral displacement of the centre plane of the hub flanges is caused as a result of the lateral fixing of the brake disc to the hub and here too, an equalization of the spoke tensions on both sides of the wheel is desirable.

Every specialist today is aware of the following problem in the case of the conventional

bicycle rear wheel. A rear wheel today with 8 to 10 sprocket sets, in the case of which on the sprocket set side of the wheel the spoke tension is approximately 100 % and more (!) greater than on the other side of the wheel, cannot maintain a desirable average tension of all spokes. This all the more so, as the differences in the tensions of individual spokes on one side of the wheel in comparison with the average are known to amount up to approximately ± 300 N. The result is a rear wheel, which frequently has to be re-centred, because individual nipples of the too loose spokes on the opposite side of the sprocket set become loose in operation. The highly tensioned spokes on the sprocket set side, however, cannot be re-tensioned sufficiently to help the spokes on the opposite side of the sprocket set to a greater tension, because their nipples, e.g., during the powerful re-tensioning with the centering spanner are torn apart into two parts or their square neck is torn off. Apart from this, in operation almost always only the spokes on the sprocket set side break as a result of fatigue. In consequence, even in the case of very expensive racing bicycles all conventional rear wheels are inferior.

Known today in the case of eccentrically spoked bicycle wheels are innumerable spoke arrangements, which are supposed to provide the most diverse advantages. All systems, however, have a common characteristic: The number of spokes, which lead from a hub flange to the wheel rim, is the same as the number of spokes, which lead from the flange on the other side of the hub to the wheel rim. It is precisely this characteristic, which leads to the consequence, that in the case of an eccentrically spoked wheel the average tensions of the spokes on both sides of the wheel perforce have to be different.

During the past years, various things have been undertaken against this undesirable phenomenon. For example, asymmetrical rims with laterally displaced spoke anchorings have been designed in the European patent No. 0494277 and the corresponding U.S. Pat. No. 5,228,756 and Japanese Pat. No. 3111074. By means of these solutions, the spoke tensions on both sides of the wheel became significantly more balanced. As various tests of the licensees bear testimony to, wheels with rims of this type are more resistant than wheels with conventional rims. At the present moment, running wheels with rims of this type are being utilized for bicycle rear wheels with several sprocket sets and also for front wheels with brake discs.

ABSTRACT OF THE INVENTION

It is the objective of the invention presented here to create an eccentrically spoked bicycle wheel, which, in comparison with a conventional eccentrically spoked wheel with the same amount of dish, the same hub, the same rim and the same number of spokes has almost or even exactly the same tensions of the spokes on both sides of the wheel and which therefore is much more durable. This - at first glance not implementable task - is accomplished by a spoked wheel with the characterizing features of the claim 1 in the most simple manner. This wheel has a different number of spokes on each side of the wheel in accordance with the principle: A greater average tension of the spokes on one side of the wheel is eliminated by a greater number of spokes on this side. The remaining questions, as to whether one can spoke a spoke system of this kind into a wheel at all and as to whether one can centre such a wheel at all, are answered in the affirmative.

BRIEF DESCRIPTION OF THE DRAWINGS

Explained in the following on the basis of the drawings is first of all the problem field on the bicycle rear wheel when utilizing conventional spoke systems. In the case of the bicycle front wheel, the problem field is analogous and is therefore not dealt with. Subsequently, various embodiments of the invention are explained in detail. In schematic illustrations the Figures depict:

Fig. 1 a part of a conventionally eccentrically spoked bicycle rear wheel in the axial sectional view in accordance with prior art;

Fig. 2 a conventionally eccentrically spoked bicycle front wheel or bicycle rear wheel in side view in accordance with prior art;

Fig. 3 a part of an eccentrically spoked bicycle rear wheel in the axial sectional view similar as in Fig. 1, however, in accordance with an embodiment of the invention;

Fig. 4 - 8 an eccentrically spoked bicycle front wheel or bicycle rear wheel in side

view similar as in Fig. 2, however, in accordance with different embodiments of the invention.

DETAILED DESCRIPTION OF THE ADVANTAGEOUS EMBODIMENTS OF THE INVENTION

Fig. 1 depicts a part of a conventional eccentrically spoked bicycle rear wheel 1 in the axial sectional view in accordance with prior art.

The tyre 2 is mounted on a conventional wheel rim 3 with a symmetrical cross section relative to the centre plane of the wheel rim M and a simple wheel rim bottom 4. Today, increasingly wheel rims with double rim bottom and with the most diverse, also asymmetrical cross sections, are utilized.

The wheel rim 3 by means of spokes 5 on the sprocket set side is connected with the hub flange on the sprocket set side in the anchoring points 6 and by means of spokes 7 on the opposite side of the sprocket set to the hub flange on the opposite side of the sprocket set in the anchoring points 8. The anchoring of the spokes in the hub flanges in most instances is implemented in the spoke holes, whereby the spokes have a rectangular bend with a spoke head at their ends. For reasons of clarity, this detail is not illustrated.

The anchoring of the spokes in the wheel rim is implemented in the centre of the wheel rim by means of spoke nipples 9, 10 in the points 11. Today these anchoring points are not always located in the centre of the wheel rim and, for example, all spokes are anchored laterally displaced from the centre plane M in the half of the wheel rim on the opposite side to the sprocket set. Or else the spokes on the sprocket set side are anchored in the half of the wheel rim opposite the sprocket set and vice versa, so that the spokes on the sprocket set side and on the side opposite the sprocket set intersect in the axial sectional view of the wheel. The objective of systems of this type is an improvement of the lateral rigidness of the wheel and of the ratio of the spoke tensions on the sides of the wheel.

The spoke nipples 9,10 today sometimes are fixed in the hub flanges instead of in the

wheel rim. The hub flanges are also not always designed with a ring-shape, but, for example the spokes, which are straight in the whole length, are anchored on the circumference of the hub in various tooth-shaped structures, so that a risk of a fracture in the bend of the spoke is eliminated.

When centering the wheel by the turning of the spoke nipples 9, 10, tensions T1, T2 are produced in the spokes 5, 7, which stress the material of the wheel rim and of the hub in the spoke anchoring points 11, 6 , 8 compressively. The very important ratio of the average spoke tensions on both sides of the wheel is dependent on the one hand on the ratio of the angles between the spokes 5, 7 and on the other hand on the centre plane of the wheel rim M. The tensions of the spokes in Fig. 1 are graphically illustrated as line sections T1 and T2, which are in an approximate ratio of 2 : 1 to one another. This today in the case of sevenfold and multiple sprocket sets leads to a very deficient lateral rigidness of the rear wheel in the direction from the sprocket set side to the side of the wheel opposite the sprocket set and to the continuous loosening of the spoke nipples on the side opposite the sprocket set. It can be mathematically proved and has been substantiated by practical measurement, that the ratio of the spoke tensions T1 : T2 reasonably accurately corresponds to the ratio of the dimensions c : d on the hub.

This rule is applicable whenever the spokes are spoked crosswise on both sides of the wheel. In doing so, the spokes with a rectangular bend at their end in each flange are inserted into the spoke holes alternately, so that they also emerge from the flange alternately from both sides in the direction of the wheel rim. The mechanical effect of this system of spoking is such, as if all spokes from every flange are brought from the centre of the spoke hole from the points 6 and 8 to the wheel rim, as is illustrated in a simplified manner in Fig. 1. The wheels in the Figures 2, 4 and 6 have crossed spokes on both sides of the wheel. This can be seen very well in the enlargements of the hub flanges in these Figures. In the case of the Figures 5, 7 and 8 it is different than is described in the Figs. 2, 4 and 6.

The dimensions c and d can be easily measured and from it one can calculate the ratio of the spoke tensions. This should to as great an extent as possible approach the ideal ratio of

1 : 1. The horizontal force components P1 and P2 of the spoke tensions T1 and T2 produced during the centering of the wheel can become smaller or greater depending on the values of T1 and T2, they are, however, perforce always of the same value in a wheel.

Located in the centre plane M of the rim are also the anchoring points of the nipples 11 in the wheel rim. This, however, is not always the case, as is manifested by the previously mentioned patent "Rim for a spoked bicycle rear wheel". The centre plane of the wheel hub flanges F is laterally displaced from the centre plane of the rim M in the direction towards the opposite side of the hub to the sprocket set side by the dimensional value e, as a result of which the spoke system obtains an eccentric shape. The dimension $e = (h - f) : 2$ is the actually undesirable amount of dish of the spoke system and the reason for the imperfection of the wheel.

In complement it shall be stated, that in the case of a conventional bicycle front wheel without a brake disc the spoke system is centred, so that the planes M and F are identical and no amount of dish e is produced. Wheel of this type have the same spoke tension on both sides, so that $c = d$ and $T1 : T2 = 1 : 1$. This is the ideal case and these wheels in operation are more durable by a multiple figure that the spoked wheels with an eccentric system of spokes.

Fig. 2 depicts a conventional eccentrically spoked bicycle front wheel or bicycle rear wheel in side view in accordance with prior art. The rear wheel 1 of this kind was illustrated in the axial sectional view in Fig. 1. The tyre, sprocket set or brake disc are not shown, in order to illustrate solely the essential.

The wheel has 24 spokes in total and these are crossed twice on both sides of the wheel. The spokes on the side of the wheel facing the viewer are represented by means of unbroken lines, the spokes on the other side of the wheel are depicted with broken lines. The intersection of the spokes on both sides serves for the better transmission of the torque generated by the chain drive or by the braking process from both flanges of the wheel hub through the spokes to the wheel rim. This additional tensile load is therefore distributed over more spokes than when a flange only has radial spokes, which cannot transmit any torque. A detail of the flange renders the layout of the spokes more clearly visible. A

similar detail is also to be seen in the Figs. 4, 5, 6, 7 and 8.

The most important point for our deliberations is the fact, that the number of spokes in accordance with this Figure is the same on both sides of the wheel and in this example amounts to 12 and therefore the ratio of the number of spokes of the spokes 7 to the spokes 5 amounts to 1 : 1. Although at the present moment in the case of bicycles innumerable spoke mounting systems are in existence, this fundamental principle is maintained in the case of every wheel, which is spoked conventionally. The number of the spokes on both sides of the wheel is the same. If hereby the average spoke tension ratio T1 : T2 amounts to approximately 2 : 1, as is graphically illustrated in Fig. 1, then on average every spoke on the sprocket set – or brake disc side of the wheel has to resist a two-times greater tension than every spoke on the other side of the wheel.

Fig. 3 illustrates a part of an eccentrically spoked bicycle wheel 1' in the axial sectional view in accordance with one embodiment of the invention. The graphical depiction of the wheel corresponds to Fig. 1 and therefore for reasons of a clearer view numbers and pointer lines to several components are made do without and only the changes in comparison with Fig. 1 are emphasized.

It is evident, that the spoke tensions T1' and T2' and perforce also their horizontal force components P1' and P2' have become greater in comparison with Fig. 1. In the case of the wheel 1 in Fig. 1, with the ratio of the dimensions c : d = 2 : 1 and the ratio of the number of spokes on the sides of the wheel of 1 : 1, the average tension of all spokes in the wheel is insufficient and from experience amounts to a maximum of 700 N. The wheel is therefore inferior due to reasons described previously. In the case of the wheel 1', however, one can even in the case of c : d = 2 : 1 and even with the same total number of spokes as in the case of the wheel 1 easily achieve a much higher average tension of all spokes of approximately 1'100 N and more.

The trick is the following: One increases the number of spokes on the sprocket set side of the wheel and simultaneously reduces their number on the side of the wheel opposite the sprocket set, so that the ratio of the number of spokes on the sides of the wheel now amounts to 1:2 . In this manner, a spoke tension ratio of the sides of the wheel of 1 : 1 is

produced, as in the case of a centrically spoked front wheel. Succinctly expressed: the two-times greater tension of the individual spokes on the side of the wheel with the sprocket set is equalized there by means of twice as many spokes. We have graphically illustrated this condition in Fig.3 in such a manner, that the line sector T1' is split-up into two equal sectors T1'/ 2 and T1'/ 2. Each one of these represents a whole spoke and corresponds to the line sector T2'. The conditions in this rear wheel, however, are not the same as in the case of centrically spoked front wheel.

The compressive stressing of the material in the anchoring points of the spokes in the wheel rims and in the hub are now the same on both sides of the wheel and also the settling phenomenons in the case of the spoke heads or of the nipples, which take place within a few tenths of millimetres, have as a result of this become equal. The minimum and maximum tensions of the individual spokes in the whole wheel now are situated within the permissible range – even in the case of a divergence of ± 300 N. The heads of the spoke nipples now have sufficient friction on their substrate and the nipples cannot become loose on their own. The spokes, however, are not excessively tensioned, so that the centering now proceeds without any difficulties and they do not break anymore even after a long period under load. As a result of this, the wheel becomes very stable and only rarely is subject to a lateral wobble.

The important lateral rigidness of the wheel from the side of the sprocket set – or from the side of the brake disk – has increased, because the overall spoke tension in the wheel has been increased and therefore also the horizontal force components P1' and P2' of the spoke tensions T1' and T2'. The horizontal forces, which, for example, are effective on the wheel 1' against the force component P1' when riding in the rocking pedalling motion, are smaller relative to P1' than the same forces relative to P1 in Fig. 1. Only the angle between the spokes 5' and the centre plane of the wheel rim has remained small. However, one can increase this lateral rigidness even more with other means, as will be described later on.

Fig. 4 illustrates an eccentrically spoked bicycle front wheel or bicycle rear wheel in side view in accordance with one embodiment of the invention. A rear wheel 1' of this type was depicted in the axial sectional view in Fig. 3. The depiction essentially corresponds to that

in Fig. 2, whereby the wheel also has 24 spokes and these are also crossed on both sides of the wheel.

The most important difference to the conventional wheel in Fig. 2 lies in the fact, that the number of spokes on one side of the wheel amounts to 8, on the other side of the wheel, however, to 16 and therefore the ratio of the number of spokes 7' to the number of spokes 5' amounts to 1 : 2. This contradicts the up until the present time always adhered to principle in the case of spoked bicycle wheels, in accordance with which the number of spokes on both sides of the wheel is the same.

The spoke tension ratios in the case of conventionally spoked wheels with some wheel hubs well-known today, which result from the ratio c : d on the hubs, are, e.g., the following:

Wheel hub Campagnolo Record, 1990, 8 – fold, length 130 millimetres: 2.13 : 1.

Wheel hub Shimano Ultegra, 2000, 9 – fold, length 130 millimetres: 1.84 : 1.

If now a wheel with a similar hub and the ratio of c : d = 2 : 1, with the number ratio of the spokes 7‘ to the spokes 5‘, however, which is proposed here, is built, then the spoke tension ratios on the sides of the wheel of 1 : 1 result, because the spokes on both sides of the wheel will have the same tension. That is our objective, the stable wheel has been created - and all this in actual fact without any effort at all!

In this Figure, in the form of a table we also indicate different suitable variants of spoke layouts crossed on both sides of the wheel and with an analogue design with different numbers of spokes. Similar tables can also be found in the Figs 5, 6, 7 and 8. Please compare the detailed view of the wheel hub flange with the detailed view in Fig.2. The spokes of the side of the wheel facing the viewer, where there are more spokes, are represented by unbroken lines, the spokes on the other side of the wheel, where there are less spokes, are depicted with broken lines. Similar illustrations you will also find in the Figs 5, 6 ,7 and 8.

Fig. 5 illustrates an eccentrically spoked bicycle front wheel or bicycle rear wheel in side

view in accordance with another embodiment of the invention. The wheel has 27 spokes in total and the ratio of the number of spokes is once again 1 : 2 as in Fig.4. There are 18 three-times crossed spokes represented by unbroken lines on one side of the wheel and 9 radially arranged spokes on the opposite side of the wheel depicted with broken lines. The overall numbers of spokes indicated in the form of a table are odd numbers and every one of them it is divisible by 3. Something of this kind does not exist in the case of conventionally spoked wheels, there every overall number of spokes is always divisible by 2.

Because on the side of the wheel with fewer spokes all spokes are radially arranged, one has to correct the calculation of the ratio of the spoke tensions T1 : T2 = c : d, as it is indicated in Fig. 1. The dimensional value c is the distance between the centre plane M of the wheel rim and the axis of the spoke (where the tensile force is effective) at the point of the spoke hole in the flange. If all spokes on this side of the wheel from the space between the flanges are inserted into the flange on the side opposite the sprocket set and then are brought to the wheel rim along the outside edge of the flange – as is usually the case -, then the dimensional value c is increased by approximately 3 millimetres (the point 8 is displaced towards the outside (towards the left) by half the thickness of the flange plus half the diameter of the spokes).

Vice versa, if all spokes from the outer side of the wheel are inserted into the flange on the side of the wheel opposite the sprocket set – which is not customary -, then the dimensional value c is reduced by these 3 millimetres. In doing so, the dimensional value d is maintained, because on this side of the wheel there are crossed spokes. One can envisage these changes with the help of the schematic drawing of Fig.3. Also in the case of the Figs. 4 and 6, 7, 8, on the sides of the wheel with less spokes one could mount the spokes indicated with broken lines crossed instead of radially and then one there also would have to carry out this correction of the calculation. Crossed spokes on both sides of the wheel, however, with some exceptions are always more advantageous, as has already been mentioned.

Fig. 6 depicts an eccentrically spoked bicycle front wheel or bicycle rear wheel in side view in accordance with a further embodiment of the invention. The wheel has 24 spokes

overall, again with the number of spokes ratio 1 : 2 as in the Figs. 4 and 5. Therefore there are 8 and 16 spokes crossed on both sides of the wheel. The spokes are arranged in groups of three. Very modern at the present time are expensive running wheels, where the spokes are arranged in a similar manner as here, but in pairs. On a rear wheel of this type, e.g., one sees one pair of the spokes, which are anchored in the wheel rim close to one another, one cannot see, however, that in all cases one of the spokes in the pair has almost double the tension of the other one and correspondingly the wheel cannot be sufficiently stable. The spokes indicated with broken lines one could also spoke radially, but with a corresponding change of the calculation of c : d, as has been described in Fig. 5.

Fig. 7 illustrates an eccentrically spoked bicycle front wheel or bicycle rear wheel in side view in accordance with another embodiment of the invention. This wheel has 25 spokes overall and the ratio of the spoke numbers here is 2 : 3 (= 1 : 1.5). There are 10 and 15 spokes on the sides of the wheel. The distances between the anchoring points of the spokes in the wheel rim are the same as in the case of all Figures with exception of Fig. 6. Systems of this kind are more suitable for a durable wheel than the system in accordance with Fig. 6, because wheels of this type one can centre better following the occurrence of a lateral wheel wobble. All total number of spokes figures indicated in the table are divisible by 5. Here too, similar as in Fig.5, the calculation of the ratio of the spoke tensions T1 : T2 has to be corrected with the help of c : d. While on both sides of the wheel the spokes are crossed, on that side of the wheel with more spokes, however, apart from the crossed spokes there are also radial spokes, which are brought along the outer side of the flange. In this case, one has to increase the dimensional value d by approximately 1.5 millimetres. If one inserts the radial spokes into the flange the other way round – which we do not favour – then one has to reduce the dimensional value d by these 1.5 millimetres. In the case of a radial spoking of the spokes indicated with broken lines, in the calculation of c : d one has to increase or reduce the dimensional value c by 3 millimetres, as is described in Fig.5.

Fig. 8 depicts a wheel in analogy to Fig. 7. It has 35 spokes overall, with a number of spokes ratio of 2 : 3 (= 1 : 1.5). There are 14 and 21 spokes on the sides of the wheel. Because of the large number of spokes, the wheel is advantageous in such instances, where higher stresses occur, and/or where an above average durability with many kilometres run

is expected (ideal for training bicycles). Here too, as in Fig. 7, one has to increase or reduce the dimensional value d, respectively, the dimensional value c, depending on the manner in which the spokes are laid out.

ADDITIONAL MEASURES

As has already been stated, it is the paramount objective of this invention to create an eccentrically spoked wheel with a durability not achieved up until now. This has been achieved by the unequal number of spokes on the sides of the wheel. There are, however, other measures, which serve this objective.

One of these is the utilization of an asymmetrical wheel rim with laterally displaced anchoring points of the spokes in the direction towards the opposite side of the wheel to the sprocket set. The ratio of the dimensions c : d on the wheel hub and therefore also the important spoke tension ratio of T1 : T2 as a result of this are reduced significantly in the calculation, because the dimensional value c is reduced and simultaneously the dimensional value d is increased. With this, the lateral rigidness of the wheel in the direction from the sprocket set or from the brake disc towards the other side of the wheel increases and also the durability of the wheel is improved.

Another measure is a sufficiently large distance from one another of the flanges on the wheel hub (2b = c + d). In this, the lengths 2a and d have to be maintained and solely the dimension c is increased. It is beyond any doubt, that the lateral rigidness of a wheel increases with the increasing distance of the flanges from one another, and this in the direction from both sides of the wheel. It is surprising, that this finding even today still is being ignored also by noted manufacturers, or else is not known. At the present moment, in the case of conventional rear wheels this distance in accordance with a well-known rule is maintained at a value of approximately 55 (± 1 millimetres). In the case of a too small distance of, for example, less than 50 millimetres, the lateral rigidness and the durability of the wheel are reduced very strongly. Vice versa, in the case of a too large distance of, e.g., more than 60 millimetres, the ratio of the spoke tensions increases to values of more than 2 : 1 and in operation very soon a loosening of the nipples of spokes with a too low tension takes place and therefore a lateral wheel wobble results. In the case of special bicycles, one

eliminates this phenomenon by the utilization of special nipples with an insert made of plastic material. One counters the very great tension of the spokes on the sprocket set side of the wheel by utilizing especially thicker spokes on this side of the wheel. These special components are difficult to obtain in the case of a repair. The great difference in the tension of the individual spokes on both sides of the wheel, however, remains unchanged and the whole solution of the problem for this reason is unsatisfactory.

PRACTICAL ADVICE

Please refer to Fig. 1.

In the case of a rear wheel hub for a racing bicycle with the following dimensions in millimetres: 2a = 130; c = 35; d = 19; distance of the wheel hub flanges c + d = 54, the ratio of the spoke tensions T1 : T2 = c : d = 35 : 19 = 1.84 : 1. In the case of a conventional spoking of a wheel with this hub (left-hand and right-hand spokes are crossed, the anchoring of the spokes in the wheel rim lies in its centre and the number of the spokes on both sides of the wheel is the same), therefore the average tension of the spokes 5 on the right (on the more stressed wheel hub sprocket set side) is 1.84 – times greater than the tension of the spokes 7 on the left (on the less stressed opposite side of the wheel hub).

Examples of the spoke tensions in wheels with the described wheel hub exploiting various claims:

1) Utilization of the number of spokes of the spokes 7' to the spokes 5' in the ratio of 2 : 3 (= 1 : 1.5) - refer to Figs. 7 and 8.

The original spoke tension ratio of 1.84 : 1 as a result of this is reduced 1.5 – times, so that T1' : T2' = 1.23 : 1.

One can make good use of the wheel, the new spoke tension ratio of 1.23 : 1 is much more favourable than the original one of 1.84 : 1 and is situated low in the acceptable range (up to approximately 1.4 : 1). One requires a conventional wheel hub and a conventional wheel

rim, only the number of spokes on the left-hand and right-hand side of the wheel is now different. For reasons described previously, it is advantageous, if on both sides of the wheel there are crossed spokes.

2) Utilization of the number of spokes ratio of 2 : 3 (as in the case 1)) and secondly, utilization of an asymmetrical wheel rim with spoke anchoring points displaced by 3 millimetres in the direction of the side opposite the sprocket set of the wheel.

First, as in the case 1): The original spoke tension ratio of 1.84 : 1 is reduced 1.5 - times.

Second, the original ratio of c : d = 35 : 19 = 1.84 : 1 changes due to the displacement of the spoke anchoring in the wheel rim by 3 mm to (c - 3) : (d + 3) = 32 : 22 = 1.45 : 1. As a result of this, the original ratio of 1.84 : 1 is reduced for the second time, this time (1.84 : 1.45 =) 1.27 - times.

The final spoke tension ratio is T1' : T2' = (1.84 : 1.5) : 1.27 = 0.97 : 1 .

We have practically achieved the ideal spoke tension ratio of 1 : 1. For this excellent solution one requires a number of spokes ratio of 2 : 3 and an asymmetrical wheel rim. Wheel rims of this kind have been on the market for many years. They not only improve the spoke tension ratio of both sides of the wheel, but also make the wheel significantly more rigid in the direction from the sprocket set side to the side opposite the sprocket set.

3) Utilization of the number of the spokes 7' to the spokes 5' in the ratio of 1 : 2 (refer to Figs. 3,4,5,6).

The original spoke tension ratio of 1.84 : 1 as a result of this is reduced 2 – times, so that T1' : T2' = 0.92 : 1.

The wheel can be made good use of, the new spoke tension ratio of 0.92 : 1 is much more favourable than the original one of 1.84 : 1. One requires a conventional wheel hub and a conventional wheel rim, only the number of the spokes on the left- and right-hand side of the wheel is now different. Because the tension T1' on the right-hand is now smaller than the tension T2' on the left-hand, this solution is very advantageous in the case of those spoke systems, where all spokes on the left are radially spoked (Fig.5), so that the torque is

transmitted exclusively through the right-hand crossed spokes.

4) Utilization of the number of spokes ratio of 1 : 2 (as in the case 3)), second, utilization of an asymmetrical wheel rim with spoke anchoring points displaced by 3 millimetres in the direction towards the side of the wheel opposite the sprocket set (as in the case 2)) and third, utilization of a wheel hub body extended in the direction towards the side of the hub opposite the sprocket set.

First, as in the case 3): The original spoke tension ratio of 1.84 : 1 is reduced 2 - times.

Second, as in the case 2): The original ratio of c : d = 35 : 19 = 1.84 : 1 changes as a result of the displacement of the spoke anchoring in the wheel rim to 1.45 : 1. The original ratio of 1.84 : 1 because of this is reduced for the second time, this time by (1.84 : 1.45 =) 1.27 - times. The spoke tension ratio T1' : T2' up until now would be (1.84 : 2) : 1.27 = 0.724 : 1.

Now the tension T1' would be too small, T2' too big. For this reason, we now utilize, third, a new wheel hub, which has to be manufactured. The original dimension d = 19 is maintained, but the dimension c = 35 on the wheel hub body is increased (1 : 0.724) – times, so that c (new) = 35 x (1 : 0.724) = 48.34. The new wheel hub has the following dimensions: 2a = 130; c = 48.34 (new); d = 19; distance of the flanges = c + d = 67.34 (new); c : d = 2.54 (new).

The final spoke tension ratio T1' : T2' = (0.724 : 1) x (1 : 0.724) = 1 : 1.

Mathematically we have achieved the ideal dimensions of the wheel hub and therefore also the ideal spoke tension ratio of T1' : T2' = 1 : 1. For this solution one requires a number of spokes ratio of 1 : 2 (as in the case 3)), an asymmetrical wheel rim (as in the case 2)) and new, a new design of the wheel hub on its left-hand side. As a result of this one obtains a rear wheel, with which the rear wheels known up until now and which are much more expensive, cannot compare. The asymmetrical wheel rim improves the rigidness of the wheel from the right. The wheel hub with a greater distance of the flanges additionally provides the wheel with a greater rigidness from the right and from the left. The spoke tension ratio of 1 : 1 prevents spoke fractures and lateral wheel wobble, which are pro-

duced by irregular settling phenomenons in the anchoring points of the spokes. It is a very important point, that one can repair the wheel very easily, because it has conventional spokes and nipples, which are cheap and which can be purchased everywhere. Also in the case of this wheel, crossed spokes on both sides of the wheel are to be recommended.

RECOMMENDATIONS, EXPERIENCES UP UNTIL NOW

The spoking of the new wheels is as simple as in the case of the conventional wheels. The centering by hand is even more easy, because one can turn the nipples on both sides of the wheels without a greater resistance. For the centering with an automatic machine, one would probably have to re-programme the machine. Important is the higher average spoke tension (of approximately 1'100 N and more), which should be measured with a spoke tension measuring device at least at certain time intervals, and the multiple straining and stretching of the wheel during centering. A good running wheel must have a good, not too light wheel rim, e.g. a aerodynamically shaped rim on a racing bicycle, approximately 19 mm wide and 20 mm high and not less than approx. 430 g heavy (asymmetrical wheel rims with laterally displaced spokes and symmetrical wheel rims with these characteristics are available in the market), conventional quality spokes with the double diameter 2/1.8 mm and good conventional milled brass nipples. To be recommended furthermore are regular spacing of the anchoring points of the spokes in the wheel rim, having the spokes crossed on both sides and overall not less than 24 spokes (better rather around 30).

For the simplification of the spoking of a wheel and for reasons of cost, we recommend the following: The bores for the spoke nipples in the wheel rim (at the centre of it or laterally displaced) should be implemented to be as simple as possible. All holes should be in a line (no zig-zag lines) and should be drilled in radial direction (vertical to the wheel axis). Directional orientations of the bores forwards, backwards, to the left or to the right are expensive, unnecessary and confusing when carrying out the spoking. A sufficient diameter of the bores has to be assured, so that the nipples if so required can assume an

inclined position in the bore on their own. The bore diameter is the diameter of the cylindrical part of the nipple utilized with an overmeasure allowance of approximately 0.5 millimetres (not only around 0.3 millimetres, as is customary in the case of directionally oriented bores).

Prototypes for trial purposes are very easy to manufacture, because one can make use of conventional wheel hubs, spokes, nipples and wheel rims. Only the number and the position of the holes for the spokes in the wheel hub and in the wheel rim are different, but one can modify available wheel hubs and wheel rims in this sense without any great effort. There are still only a few experiences with the wheels in operation up to now. A few wheels are in continuous operation and up to now they do not manifest any phenomenons of fatigue whatsoever. Vibrations of the bicycle in the case of fast running – as some theoreticians might well fear – are to a great extent unknown.

With what has been described up to now, the spoke tension in the case of eccentrically spoked bicycle wheels can be standardized. The method in accordance with the invention is the following one: In that the wheel hub at the individual sides of the centre plane of the wheel rim M is equipped with a correspondingly not equal number of anchored spokes, the average tension of the spokes, to such an extent as this is desired, can be equalized. As already described, the total tensions of the spokes, which lead from the wheel hub on the one, resp., on the opposite side of the centre plane of the wheel rim M in the direction towards the wheel rim, are of a different value. This can be equalized by means of the differing numbers of anchored spokes.

THE FUTURE

The possibilities described for the exploitation of the patent have absolutely not been dealt with exhaustively. Over the course of time, assuredly spoke systems unknown up until the present moment with different number of spokes – and spoke tension ratios will be produced. All these new variants, however, are covered by the claim 1, whereby the number of the spokes on the sides of an eccentrically spoked bicycle wheel is different.

We are of the opinion, that this document will revolutionize the spoking of the running

wheels. Every manufacturer of bicycles or running wheels of note will sooner or later be compelled to give serious thought to this. It is a very infrequent occasion, that a problem, which has been known for decades and which has become bigger and bigger and for the solution of which the world's biggest companies have been undertaking efforts with the most diverse means and at great expense, can be eliminated in such a manner. Our solution to the problem – the highly undesirable unequal spoke tensions on the two sides of a bicycle wheel – is very astonishing. It is, however, by far the most simple, the cheapest and the most perfect solution to the problem.

CLAIMS

1. Eccentrically spoked bicycle front wheel or bicycle rear wheel consisting of a wheel hub, which is connected by means of spokes to a ring shaped wheel rim under tension, in the case of which the centre plane of the anchoring points of the spokes in the wheel rim is laterally displaced from the centre plane of the wheel hub flanges or from the centre plane of the anchoring points, which are constructed differently, on the sides of the wheel hub (F), **characterized in that** the number of spokes, which from the wheel hub on that side of the centre plane of the wheel rim (M) lead in the direction towards the wheel rim, on which a higher sum of the tensions of these spokes is present, is greater than the number of spokes, which from wheel hub on the opposite side of the centre plane of the wheel rim (M) lead in the direction towards the wheel rim, on which a lower sum of the tensions of the spokes is present.

2. Eccentrically spoked bicycle front wheel or bicycle rear wheel in accordance with claim 1, **characterized in that** the number of spokes, which from the wheel hub on the one side of the centre plane of the wheel rim (M) lead in the direction towards the wheel rim and the number of those spokes, which from the wheel hub on the other side of the centre plane of the wheel rim (M) lead to the wheel rim, are in the ratio of 2 : 3.

3. Eccentrically spoked bicycle front wheel or bicycle rear wheel in accordance with claim 1, **characterized in that** the number of spokes, which from the wheel hub on the one side of the centre plane of the wheel rim (M) lead in the direction towards the wheel rim and the number of those spokes, which from the wheel hub on the other side of the centre plane of the wheel rim (M) lead to the wheel rim, are in the ratio of 1 : 2.

4. Eccentrically spoked bicycle front wheel or bicycle rear wheel in accordance with claim 1 or one of the claims 2 and 3, **characterized in that** it has a wheel rim, in the case of which the centre plane of the anchoring points of the spokes in the wheel rim is laterally displaced from the centre plane of the wheel rim (M).

5. Eccentrically spoked bicycle front wheel or bicycle rear wheel in accordance with claim 1 or one of the claims 2 to 4, **characterized in that** it has a rear wheel hub, in the case of which the distance of the centre planes of the wheel hub flanges or of the centre planes of the constructed differently anchoring points of the spokes on the sides of the wheel hub (c + d), amounts to 58 or more millimetres.

6. Eccentrically spoked bicycle front wheel or bicycle rear wheel in accordance with claim 1 or one of the claims 2 to 5, **characterized in that** on the wheel hub and/or on the wheel rim it has a sticker with an inscription "spokes 2 : 3" or "spokes 1 : 2" or with another suitable text, which draws attention to the unaccustomed and for the centering of the wheel important arrangement of the spokes on the sides of the wheel.

7. A bicycle with at least one eccentrically spoked wheel in accordance with claim 1 or one of the claims 2 to 6.

8. Eccentrically spoked bicycle front wheel or bicycle rear wheel, consisting of a wheel hub, which by means of spokes is connected with a ring-shaped wheel rim under tension, in the case of which the centre plane of the anchoring points of the spokes in the wheel rim is laterally displaced from the centre plane of the wheel hub flanges or from the centre plane of the constructed differently anchoring points of the spokes on the sides of the wheel hub (F), **characterized in that** the number of spokes, which lead from the wheel hub on one side of the centre plane of the wheel rim (M) in the direction towards the wheel rim, is not the same as the number of those spokes, which from the wheel hub on the other side of the wheel rim centre plane (M) lead in the direction towards the wheel rim.

9. Method for the standardization of the spoke tensions in the case of eccentrically spoked bicycle wheels, in that the average tension of the spokes, which from the wheel hub on that side of the centre plane of the wheel rim (M) lead in the direction towards the wheel rim, where a greater overall tension of the anchored spokes is present, is equalized to such an extent as is required with the average tension of those spokes, which from the wheel hub on the opposite side of the centre plane of the wheel rim (M) lead in the direction towards the wheel rim, where a lower overall tension of the anchored spokes is present, **in that** the wheel hub on the individual sides of the centre plane of the wheel rim (M) is

equipped with a correspondingly not equal number of anchored spokes.

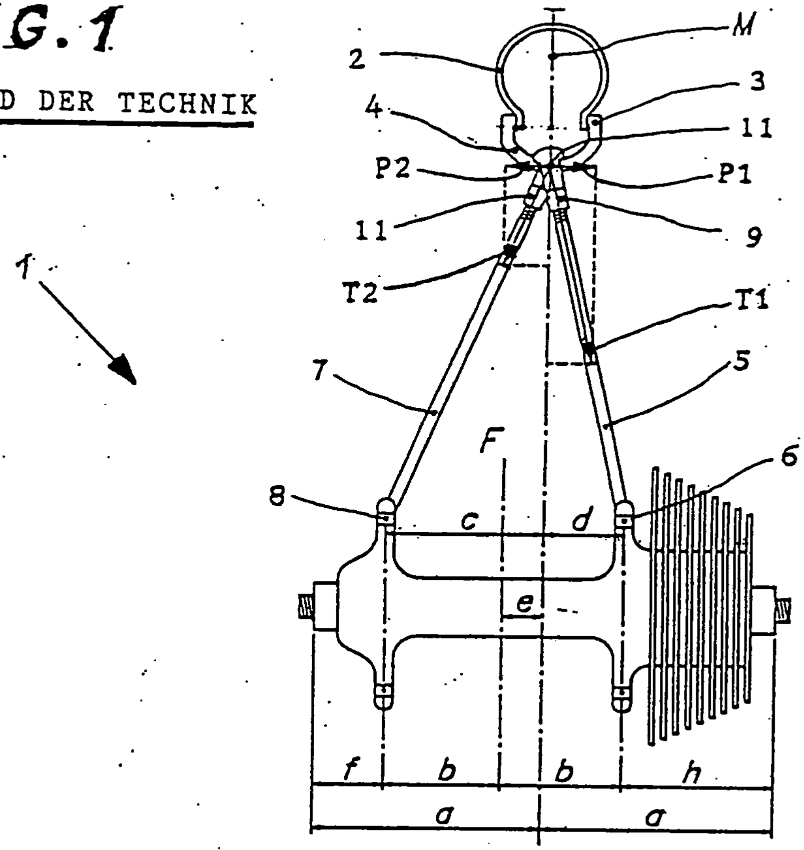
ABSTRACT

An in accordance with every embodiment of the invention eccentrically spoked bicycle front wheel or bicycle rear wheel on its sides has an unequal number of spokes, but a practically equal or exactly equal average tension of the spokes. For several reasons, this wheel in operation is significantly more durable than a comparable conventional eccentrically spoked bicycle front wheel or bicycle rear wheel, which on its sides has an equal number of spokes, but significantly unequal average tensions of the spokes.

(Fig. 4)

FIG.1

STAND DER TECHNIK



$c : d \cong T1 : T2$

FIG.2

STAND DER TECHNIK

SPEICHEN: 1:1

total 24: ——— 12; ——— 12

DETAIL

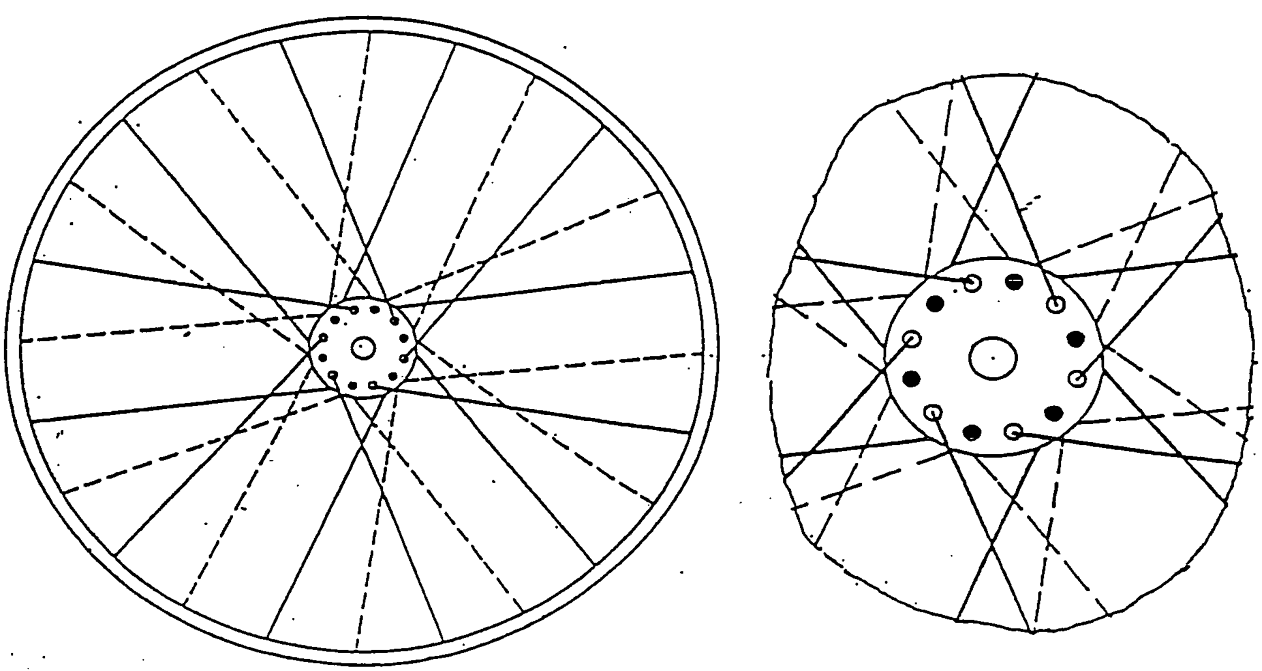


FIG. 3

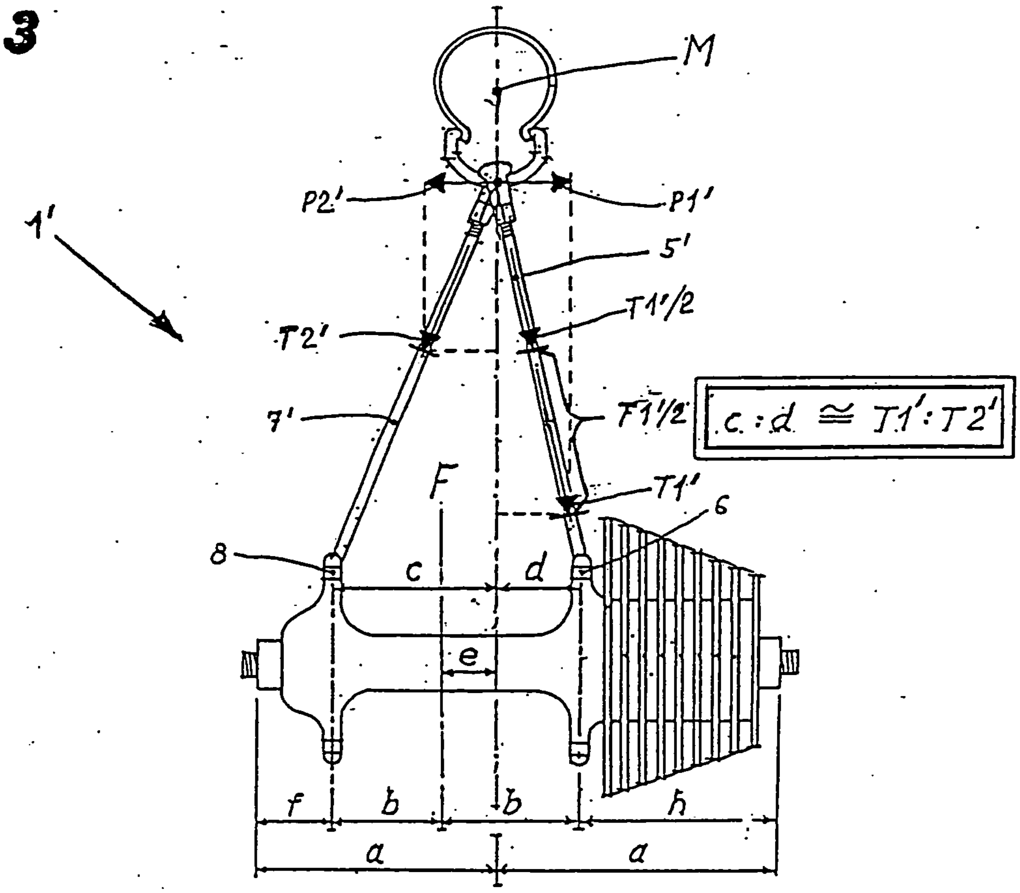


FIG. 4

SPEICHEN: **1 : 2**

total 24: - - - 8; ——— 16

ANALOGE VARIANTEN:

total 24: - - - 8; ——— 16

total 30: - - - 10; ——— 20

total 36: - - - 12; ——— 24

total 42: - - - 14; ——— 28

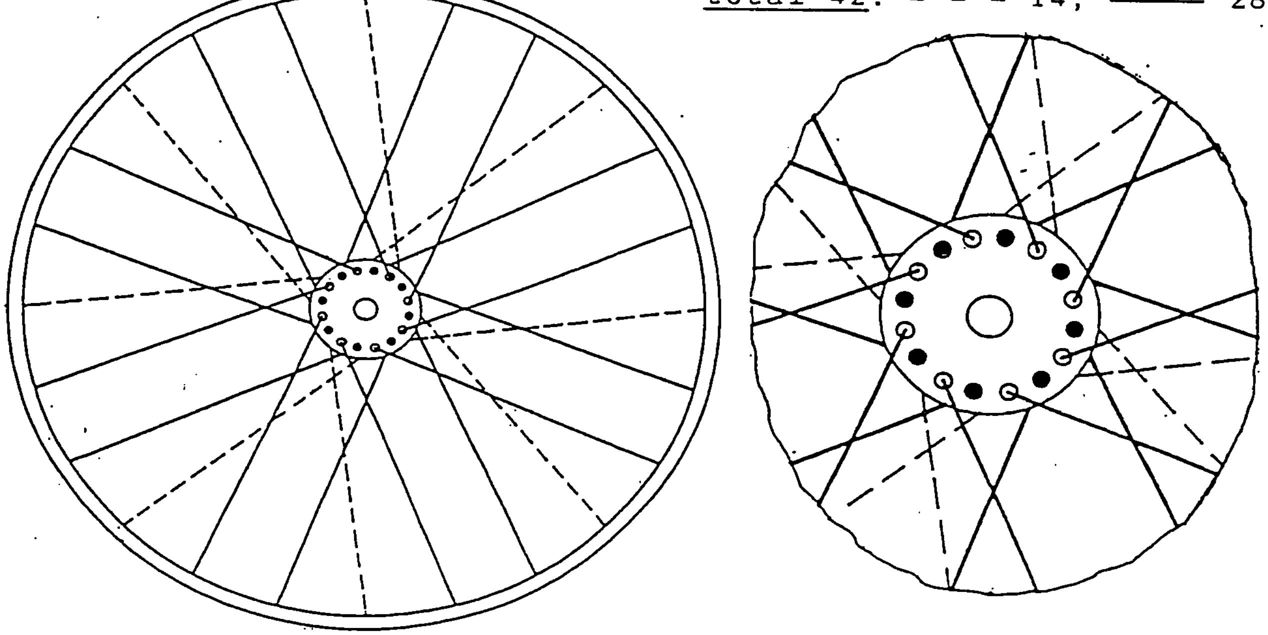
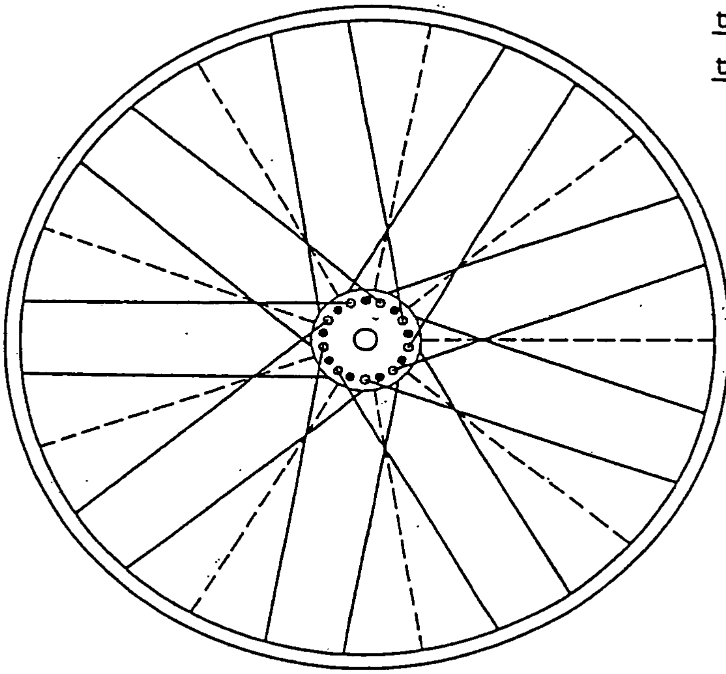


FIG. 5

SPEICHEN: **1:2**

<u>total 27</u>: - - - 9; ——— 18



ANALOGE VARIANTEN:

<u>total 21</u>: - - - 7; ——— 14
<u>total 27</u>: - - - 9; ——— 18
<u>total 33</u>: - - - 11; ——— 22
<u>total 39</u>: - - - 13; ——— 26
<u>total 45</u>: - - - 15; ——— 30

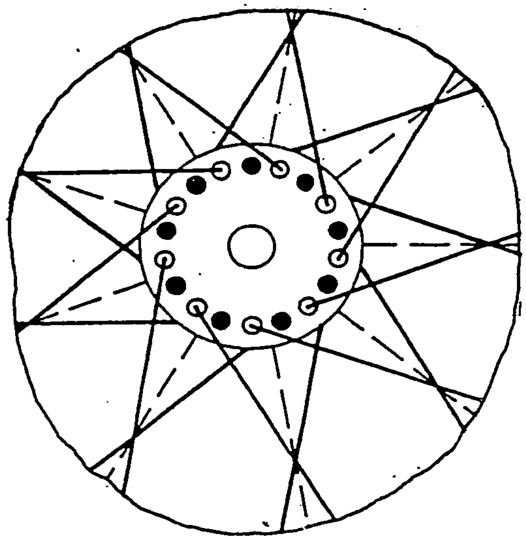
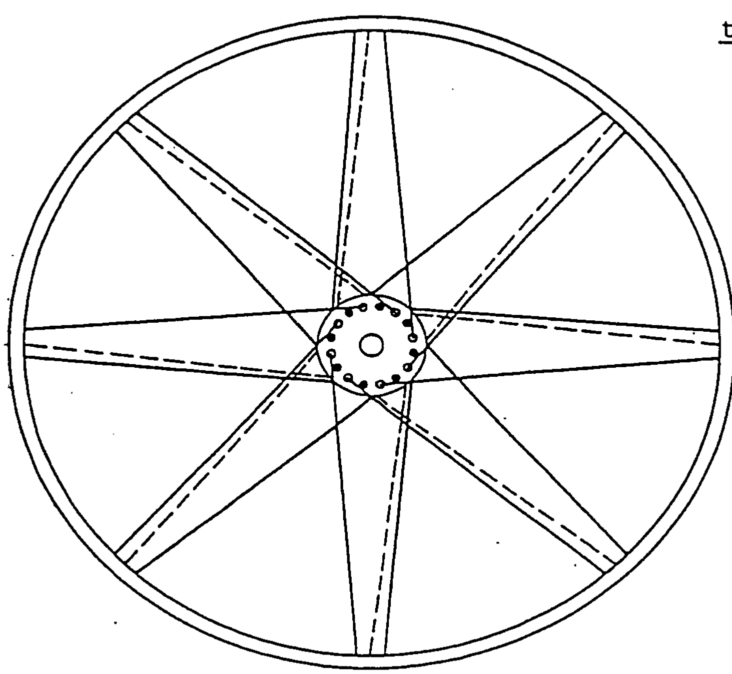


FIG. 6

SPEICHEN: **1:2**

<u>total 24</u>: - - - 8; ——— 16



ANALOGE VARIANTEN:

<u>total 24</u>: - - - 8; ——— 16
<u>total 30</u>: - - - 10; ——— 20
<u>total 36</u>: - - - 12; ——— 24
<u>total 42</u>: - - - 14; ——— 28

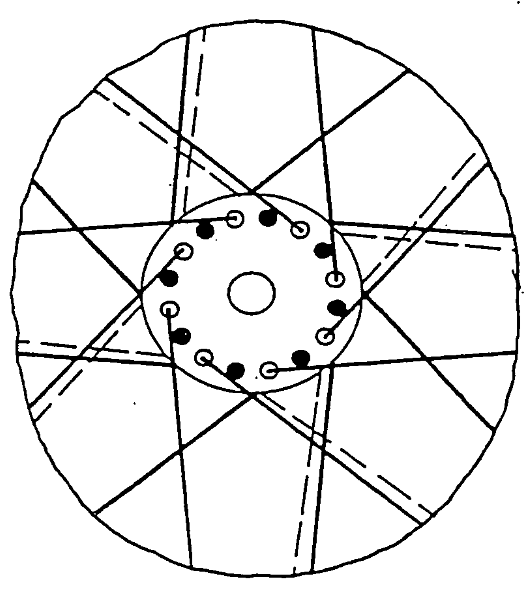


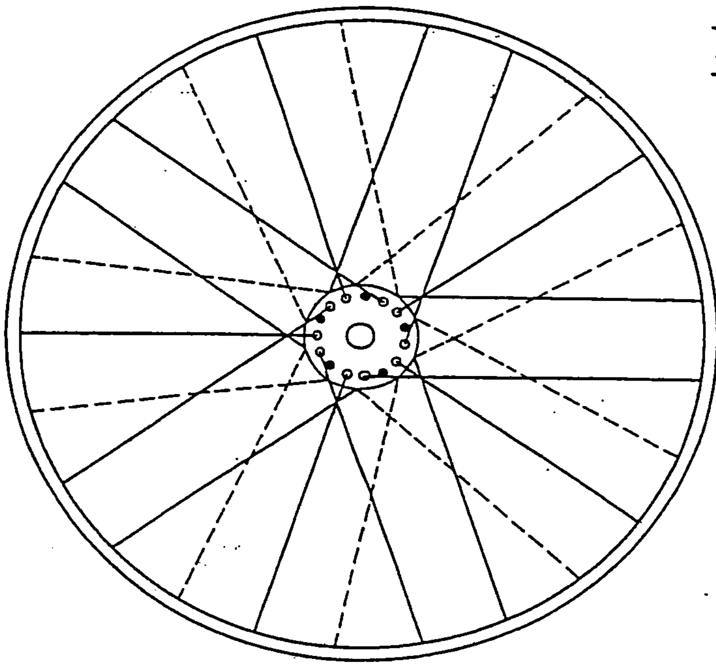
FIG.7

SPEICHEN: **2:3**

total 25: - - - 10; ——— 15

ANALOGE VARIANTEN:

total 20: - - - 8; ——— 12
total 25: - - - 10; ——— 15
total 30: - - - 12; ——— 18
total 35: - - - 14; ——— 21
total 40: - - - 16; ——— 24



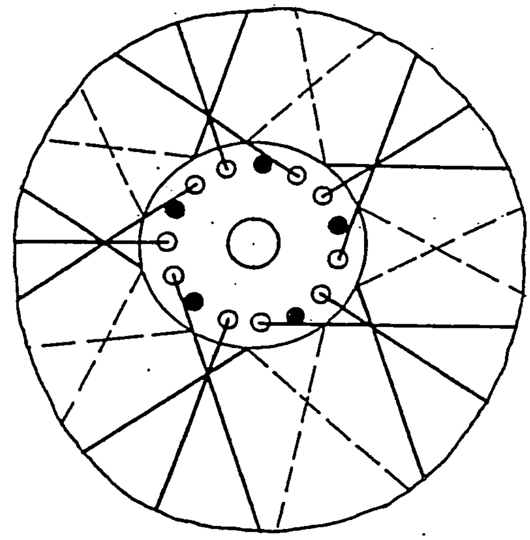


FIG.8

SPEICHEN: **2:3**

total 35: - - - 14; ——— 21

ANALOGE VARIANTEN:

total 20: - - - 8; ——— 12
total 25: - - - 10; ——— 15
total 30: - - - 12; ——— 18
total 35: - - - 14; ——— 21
total 40: - - - 16; ——— 24